

Vodcast embedded with physics education technology simulation in learning projectile motion

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ABSTRACT

The challenge of creating reliable technology-based resources for science learning is a perennial challenge in Philippine education, with limited learning materials accessible to all learners. This study is about the development of a vodcast embedded with physics education technology (PhET) simulation that served as supplementary learning material for grade 9 science in response to the scarcity of dependable visualization materials. The study employed the developmental research design with analysis-design-development-implementation-evaluation (ADDIE) model as the developmental framework. The vodcast evaluation tool, achievement test questionnaire, and vodcast perception survey questionnaire for students and teachers were used in the data collection, while the Kendall's W statistic, mean, percentage, and gain score were used in the data interpretation. The teacher respondents (N=64) have moderate agreement on the ranking of topic difficulty, with Kendall's W of 0.45. The researcher-made vodcast attained an overall rating of 4.78 from experts, which implies that the vodcast can be very good material for classroom implementation. The developed achievement test has acceptable difficulty and discrimination indices. The implementation stage yielded a low normalized gain, which can be accounted for by unfocused attention during the pandemic. Nevertheless, the voicecasts were found very useful in learning projectile motion, as perceived by both students and teacher-observers.

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1. INTRODUCTION

Philippines implemented in 2012 an educational reform known as the K to 12 Program in pursuit for the Filipino learner's holistic development and global competitiveness. The Department of Education provided teacher's guide and learning materials to be utilized in the attainment of the set learning competencies [1]. However, the 2018 Programme for International Student Assessment (PISA) result placed Philippines in the score 357 in science that was way beneath the average of Participating Organisation for Economic Co-operation and Development (OECD) countries as cited by Bernardo *et al.* [2].

Added to this challenge is the COVID-19 pandemic that has disrupted the usual and normal way of teaching and learning in all fields of discipline [3]. To address this, the schools implemented modes of

deliveries such as printed modules, online delivery for schools with means and information and communication technology (ICT) infrastructures supportive to online mode of instruction, and TV/Radio broadcast instruction [4], [5]. Generally, students preferred modular distance learning over online learning [6]. Under modular delivery, students were provided with printed materials to serve self-learning modules (SLMs) that made learning very difficult for some students [7]. This is especially true as well in science that required clear visualization of the concepts being taught if the cognitive theory of multimedia learning (CTML) of Mayer [8] is taken into consideration.

Meanwhile, grade 9 students have a hard time understanding projectile motion. This persistent difficulty has caught the attention of many educational researchers as evidenced in some studies [9]–[11] already conducted. That is why, a number of research studies [12]–[15] were carried out as implementing strategies that aimed at addressing this difficulty and misconceptions among students. But, only a few of these researches utilized digital technology as a teaching-learning strategy on the said topic.

But, in this new era of technological advancement, educators may create instructional materials in the form of vodcasts that will motivate, elucidate, and create avenues for effective audiovisual intervention for learners intended for the difficult topics such as projectile motion. Vodcasts were found to have positive impacts and outcomes in student achievements as revealed in some research studies [16]–[18]. With teacher-made videos, the needs, the interests and the common language of a group of learners may be given utmost consideration. Teacher-made videos can make learning enjoyable and easier [19], influence students' learning, and improve performance [20]. Also, inclusion of physics education technology (PhET) simulation increased the power of visualization for learning Physics concepts [21].

Although a lot of ready-made videos can be found in the internet and these can be used at the convenience of both teachers and students, some of these videos may not be configured according to the learning competencies stipulated in the Department of Education science curriculum and have not been evaluated by experts. These videos may contain limitations that would cause misconceptions among the learners. A study on Youtube uploaded learning materials [22] showed that the videos contained information that could put to risk learners in terms of ethical and safety concerns. Preventive suggestions mentioned that competent institutions and individuals should prepare videos about this in order to target specific content accurately, making it more reliable, as well as heightened video quality.

Furthermore, the separate effects of PhET and of vodcasts and/or videos for educational purposes have long been examined by various researchers. But, still limited similar studies were conducted in the Philippines that verify its positive significance on Filipino students' performances and perceptions. Ulla *et al.* [17] recommended development of more vodcasts as supplementary learning materials across the different topics in physics. The exact impact extent brought by the combination of audio-visual in learning is not yet fully defined and its portability reduces access cost compared to printed material.

In the light of the above stated information, the study was conceptualized in order to develop teacher-made vodcasts with PhET simulation that would serve as strategic learning supplement for physics. Specifically, this study sought to:

- Describe the profile of respondents in terms of: i) perception of Grade 9 students about MDLM Implementation and ii) concordance of teacher's ranking of difficult Science 9 topics.
- Describe the processes involved in the development of a vodcast embedded with PhET simulation for enhanced learning in projectile motion.
- Describe and assess the prototypes of the vodcasts embedded with PhET simulation in terms of: i) content quality, ii) instructional quality, iii) delivery quality, and iv) technical quality
- Implement the developed vodcasts to the respondents.
- Describe the final version of the developed vodcasts based on student-respondents' and teacher-observers' perceptions.

2. METHOD

2.1. Research design

The study employed the developmental research design following the analysis-design-development-implementation-evaluation (ADDIE) model which according to Artman [23], does not only serve as a vital guide in instructional video development but can increase as well the effectiveness of the video content. Utilizing the ADDIE model, a one-group pretest-posttest quasi-experimental design (O1×O2) in the implementation and evaluation stages was used. Pretest was first given before conducting the lesson with the use of the developed vodcasts. The posttest was then administered after two weeks of vodcast implementation. Quantitative data were gathered in the form of survey responses, evaluation ratings, pretest scores and posttest scores.

2.2. Procedure

In order to come up with the vodcasts embedded with PhET simulation, the researchers followed the procedure below with the ADDIE model as its instructional design framework, as shown in Figure 1. Two surveys were conducted in the analysis stage, followed by the design stage, where the planning for actual vodcast-making, the storyboard-making or scriptwriting, and the PowerPoint presentation-making were done. The development stage involved the recording and editing of vodcasts, as well as the crafting of test and survey questionnaires. The developed vodcast and questionnaires were then used during the implementation stage where they were evaluated by both science teacher-observers and student-respondents.

2.3. Data analysis

Statistical analyses were carried out to interpret the data gathered. Specifically, Kendall's W was used to see the extent of agreement of the respondents on the ranking of topic difficulty. The mean was used to summarize the perceptions of the evaluators, and the normalized gain was used to identify the increment of the answer from pretest to posttest.

2.3.1. Kendall's W statistic or coefficient of concordance

This non-parametric statistic assesses the level of agreement among various raters. The raters arranged a certain set of variables from the highest to the lowest in terms of perceived impact, like from most difficult to least difficult. The values ranged from 0 to 1. A value of zero denotes no agreement at all between raters, while a value of 1 denotes perfect agreement [24]. Kendall's W will establish if the raters agree with their ranking, and from the perspective of a pedagogical developer, this statistical tool can greatly help in making more informed decisions. Hence, this is very important in this study.

2.3.2. Mean and percentage

The mean was used in the analysis of the data in five different ways. A mean was computed to analyze the responses of grade 9 students to the Medley Management Inc. (MDLM) implementation in science. Another mean was obtained from the voicecast evaluation tool ratings by content and ICT experts. The other two computed means were from the pretest and posttest scores, and lastly, from the vodcast perception survey responses by both teacher-observers and student-respondents. The means were then interpreted based on a description. The percentage was calculated by dividing the number of responses that fall under a particular description by the total number of responses in an item, then multiplying by 100%.

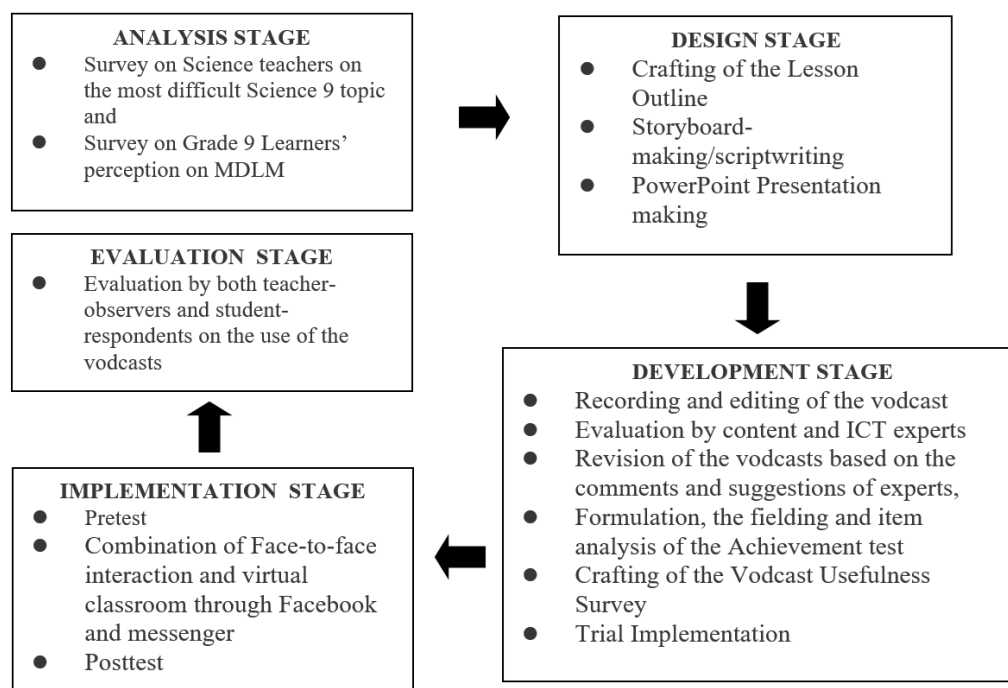


Figure 1. Step by step process of developing the vodcast using the ADDIE model

2.3.3. Normalized gain

The normalized gain score was computed to obtain insight on the influence of the vodcast on the conceptual understanding of the grade 9 physics students. The normalized gain value is extent of increment from pretest to posttest a positive gain would correspond to low, medium, and high gain [25]. A zero gain indicates a stable response, while a negative gain would indicate that the intervention did not engender learning or even become counterproductive. The choice of normalized gain provides the researcher better understanding of the learners as to who needs extra attention based on the gain score or if the intervention really works by having no negative gain.

3. RESULTS AND DISCUSSION

3.1. Analysis stage

Before the design and development, a needs analysis was conducted. A total of forty-six grade 9 students at Esperanza National High School participated in the survey on MDLM that would reveal their experiences and perceptions about the said learning modality. Table 1 lays out the mean rating for each statement and the corresponding percentage of responses. The percentage of responses for statements 1 and 2 in the questionnaire can be supported by the study of Dangle [26], wherein most of the learners who participated in their study were having difficulty with the modular distance learning modality. In terms of whether they needed supplementary video lessons or not, the mean rating was 4.11 in favor of the ones who agreed. This could mean that the students found the modules insufficient for learning. In the study conducted by Insorio and Macandog [27], video resources helped the students understand the mathematics concepts and complemented lessons on the modules. In the same way, the grade 9 respondents to the MDLM survey revealed their difficulty in their studies and needed supplementary materials such as video lessons that would enhance their understanding of science concepts.

Moreover, in the analysis stage, 64 DepEd teachers participated in a survey on the most difficult science topic. Based on Figure 1, the majority of the teacher-respondents ranked projectile motion as the most difficult to teach and usually as the least learned topic by students during the fourth quarter of science 9. Their responses were tabulated and Kendall's W statistic was computed which is 0.45 which means that there was a moderate agreement among science teachers. The survey results agreed with the study of Kusairi *et al.* [9] wherein Indonesian students experienced some difficulties in understanding the concept of projectile motion. Moreover, the study by Defiante and Rohmi [11] shared the findings that majority of the respondents had misconceptions about projectile motion after online learning during the pandemic.

Table 1. Mean responses of grade 9 student-respondents on the MDLM implementation survey (N=46)

Statement No.	MR	De	Percentage of responses (%)		
			HA and A	NS	HD and D
1. I am having difficulty with modula distance learning.	3.28	NS	52	22	26
2. I am having difficulty in answering science modules.	3.20	NS	41	33	26
3. I have enough time to answer all my modules in science.	4.04	A	74	26	0
4. I can answer all science modules on my own.	3.78	A	67	20	13
5. My parents assist me in answering the module.	3.46	A	52.2	30.4	17.4
6. I seek the help of science teachers especially when I find the lesson in the module difficult.	3.30	NS	45.7	32.6	21.7
7. I tune in to Esperanza NHS Radio station to help me.	3.85	A	71.7	10.9	17.4
8. I watch YouTube videos and other educational videos to help me in answering the modules.	4.33	SA	93.48	2.17	4.35
9. I think I will learn more if there are helpful visuals/images/animations/simulations and narrated explanations in a video.	4.28	SA	93.48	2.17	4.35
10. I need supplementary video lessons to understand the lesson well and to answer the Science modules correctly.	4.11	A	82.6	10.9	6.5
Overall mean rating	3.76	A			

Note: MR-mean rating; De-description; HA-highly agree; A-agree; NS-not sure; D-disagree; HD-highly disagree

3.2. Design stage

The content of the vodcast was designed based on the Department of Education prescribed content standards. The researcher referred to the vodcast evaluation tool adapted from Ulla *et al.* [17] and Naga Division Memo No. 441 s. 2019 Division Guidelines and Processes for LRMDs as the evaluation tool for teacher-developed learning materials. Indicators of a good instructional vodcast were identified under content quality, delivery quality, technical production, and instructional quality. After planning for the vodcasts, scriptwriting and the storyboard making through the use of PowerPoint were carried out. There were four

PowerPoint presentations for the topics namely uniformly accelerated motion, freefall, projectile motion 1, and projectile motion 2 so there were four sets of vodcasts.

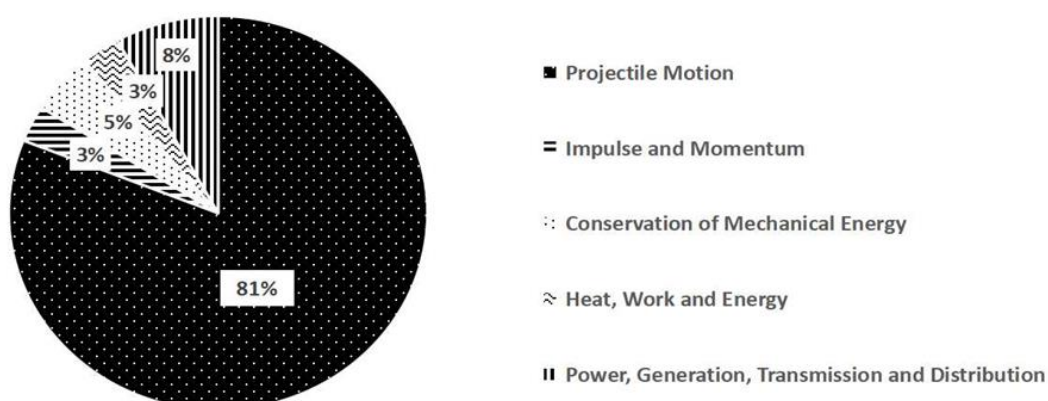


Figure 2. Percentage distribution of science teachers who ranked science topics in terms of difficulty (N=64)

3.3. Development stage

At this stage, the first versions of the vodcasts were produced using the open broadcaster software (OBS) Studio for recording, and Wondershare Filmora for editing. The developed material was then rated by both content and ICT experts with the use of the vodcast evaluation tool. Several iterations for any small increment of improvement were done to arrive to the most optimum version. Now, Table 2 shows the consolidated mean rating of the vodcast evaluation survey. The mean rating for content quality as evaluated by six evaluators, of which three were content experts and three were ICT experts was 4.96 which is very satisfactory. As to the delivery quality, the mean rating was 4.78 (very satisfactory). In terms of instructional quality, a mean rating of 4.77 (very satisfactory) was attained while that of technical production, a mean rating of 4.62 (very satisfactory) was achieved. The overall rating by all experts was 4.78 (very satisfactory).

Table 2. Consolidated mean rating of vodcast evaluation survey (N=6)

Indicators	Mean rating	Description
Content quality	4.96	Very satisfactory
Delivery quality	4.78	Very satisfactory
Instructional quality	4.77	Very satisfactory
Technical production	4.62	Very satisfactory
Overall mean	4.78	Very satisfactory

In addition to the ratings of the vodcasts, the evaluators gave comments and suggestions. These observations of the experts supported the overall mean rating of 4.78 (very satisfactory) since they pointed out some positive aspects of the developed vodcasts. A content evaluator appreciated the use of both English and Filipino languages in the video lesson. This was one of the researcher's ways of code-switching, making the explanations clear and relatable to students. In the study of Maluleke [28], he stated that code-switching is an empowering strategy and can scaffold primary school learners leading to improved mathematics performance, which is one of the waterloo subjects for South African learners. Additionally, a content expert and an ICT expert suggested putting some sound effects such as timer/bell/celebratory sound effects to make the vodcast more interesting and motivating. The results of Liwanag *et al.* [29] underscored that the elements of sound provided positive influence on students' engagement, confirms the arousal theory in the context of student engagement in any forms of e-learning environment. Putting some sound effects and other suggestions by the experts were also incorporated in the revised vodcasts.

Overall, the developed vodcasts had a rating of 4.86 based on content experts' evaluation. This implied that the set of developed vodcasts was found to be very useful in supplementing the lesson in projectile motion/Freefall/UAM. A total of 12 revised vodcasts or versions 2.0 were then uploaded to YouTube Channel of the researcher for easy access of the respondents. The vodcast with the shortest duration of 2 min and 32 seconds was projectile motion 2 Part 1, while the vodcast with the longest duration of 11 min and 46 seconds was uniformly accelerated motion 1. This only implied that educational vodcast making is a feasible undertaking for teachers. It was also during the development stage that the test questions for the pre-

and posttest were planned out and written. There were 35 conceptual questions initially formulated by the researcher. The questionnaire was pilot-tested among grade 10 students of Esperanza National High School through the use of google forms. A total of 18 questions were included in the final Achievement that was used as pretest/posttest. Moreover, the vodcast perception survey questionnaire was crafted during the development stage of this study. The survey questions were adapted and modified from Liwanag *et al.* [29] student perception questionnaire.

3.4. Implementation stage

Three weeks before the implementation, assent and consent forms were distributed and a phone call was done for each prospect respondent. Out of 75 students invited, only 68 students became respondents, 25 of which were high performers, 21 were average performers and 22 were low performers. On the first day of implementation, all student-respondents were oriented on the processes involved in the conduct of the study. In the following week, the researcher conducted a series of lessons integrating the developed vodcast embedded with PhET simulation. Simultaneous with the face-to-face interaction was the conduct of asynchronous class using the Facebook page as a virtual learning environment and Messenger as an additional means for communication. The developed vodcasts and the instructions were posted in the respective Facebook pages of the three classes. The implementation took two weeks for completion.

Table 3 reveals the outcomes of the implementation of the developed forecasts on three groups of classes, namely high-performing, average-performing, and low-performing, in terms of normalized gain. Out of 18 items, the mean pretest score of the high-performing class was 5.36, while the average-performing class and low-performing class were 4.95 and 6.55, respectively. Notably, the average-performing class had the highest mean posttest score. Now, for the class gain, the average performing and high performing classes had almost the same gain, 0.25 and 0.22, respectively, while the low performing class had the least class gain of 0.04. Overall, the class gain was 0.17, which meant a low gain of 17% of the entire class on average. This is similar to the results of Liwanag *et al.* [29] of 0.24 class gain, which also meant low gain. The study of Ndiokubwayo *et al.* [30] also supported this result since its implementation of PhET simulation and YouTube videos had normalized gains of 12% and 11%, respectively. The poor overall gain of the three groups of respondents in this study could be attributed to their lack of focus since the podcasts were posted on the class Facebook page, which would divert their attention to something else. Some respondents expressed time management problems because there were a lot of activities to perform in other subject areas. When they watched the vodcasts on the YouTube channel, they could not focus due to some advertisements that would pop up. Internet connectivity problems would also discourage them from continuing to watch based on an informal interview. Correspondingly, Adnan and Anwar's [31] findings highlighted that technical and monetary issues regarding internet access impeded the attainment of desired results in online learning in underdeveloped countries like Pakistan.

3.5. Evaluation stage

After taking the posttest, the 68 student-respondents answered the vodcast perception survey, which disclosed their perceptions, feelings, and experiences during the implementation of the developed vodcasts. The six teacher-respondents also revealed their perceptions through the survey questionnaire, and Table 4 presents the consolidated mean rating of their answers. Most of the respondents agreed that the developed vodcasts had positive impacts on them since the mean rating for each item containing positive statements about the vodcasts fell under the interpretation of either very true, as can be gleaned from Table 4. The result concurred with the study of Ulla *et al.* [17], wherein the developed vodcast had a “very useful” interpretation with a mean rating of 4.31 as perceived and rated by the grade 11 physical science student respondents. The respondents in this study viewed their experience favorably with the voicecasts embedded with PhET simulation, despite the low-class gain attained. On the same note, the findings of Ali [32] revealed the interest of students in watching videos for academic purposes, and these students thought that watching educational videos led to improved academic results. The results of this study are affirmed by Javier [16] in her study, wherein the student-respondents in the modular distance learning study considered voicecast as motivating and enjoyable as an instrument in presenting lessons in English. This is further supported by Vergara [33], whose findings in her study showed that the use of videocast as supplementary material had a positive influence on students’ perceptions of science.

Generally, the six teacher-observers who had watched over their students for the two-week class instruction, with the use of the developed vodcasts in both face-to-face and virtual learning platforms, agreed on the positive impacts of the vodcasts on their students in terms of engagement, motivation, attitude, and learning.

Table 3. Average normal gain of the student respondents (N=68)

Achievement test (I=18)	High performing class (N=25)	Average performing class (N=21)	Low performing class (N=22)	Mean average
Mean pretest score	5.36	4.95	6.55	5.62
Mean posttest score	8.2	8.52	7.45	8.06
Class gain	0.22	0.25	0.04	0.17
Interpretation	Low gain	Low gain	Low gain	Low gain

Legend: N-number of respondents; I-number of items

Table 4. Consolidated mean rating of vodcast perception survey of both students (N=68) and teacher-respondents (N=6)

Respondents	Overall mean	Interpretation
Students (N=68)	4.27	Very True
Teachers (N=6)	4.67	Very True

Therefore, both the teachers and students found the developed vodcasts useful in the teaching-learning process. In line with this is the study of Villaruz *et al.* [34] whose findings showed that the use of vodcast provided medium gain to science learning and the in-service teachers reflected that a vodcast can serve as stand-alone learning material.

4. CONCLUSION

Based on the results of the study, it can be concluded that a clear visualization of the concepts of Projectile Motion was needed by grade 9 students of Esperanza National High School, S.Y. 2021-2022 and that this could be met through the use of vodcast embedded with PhET simulation. Second, the developed vodcast by the researcher can be used for enhanced learning in Projectile Motion and the researcher-made achievement test can be used as pretest/posttest in the classroom. Third, educational vodcast making is a feasible task for a teacher. Teachers can design, develop and implement vodcasts that will be tailor-fitted to the needs, interests and native language of their students by maximizing the use of technology. Lastly, although the use of vodcast embedded with PhET simulations as supplementary learning material in this study had a low influence on the students' conceptual understanding of Projectile Motion because of the low over-all gain result of the respondents, the developed vodcasts had positive impacts on the learning process as perceived by both teachers and students during the evaluation stage. The results of this study could serve as baseline information that would encourage school administrators to craft a school improvement plan that would guide and sustain teachers to develop their instructional vodcasts.

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